Claims

We claim the following:

1) (Canceled)

2) (Currently Amended) A ~~method of~~ process for using a compound of the Formula 1 in a process,

(cation)($R'SO_4$)
Formula 1

comprising the step of: employing the compound as a solvent, or solvent additive in a chemical process, ~~or~~ ; employing the compound as an extraction solvent for a material separation; or employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit, wherein:

R' is selected from the group consisting of a linear or branched, saturated or unsaturated, aliphatic or alicyclic, functionalized or non-functionalized alkyl radical with 3-36 carbon atoms, wherein R' is optionally functionalized with one or more X groups; X is selected from the group consisting of an –OH, -OR'', -COOH, -COOR'', $-NH_2$, $-SO_4$, -F, -Cl, -Br, -I or –CN; and R'' is selected from the group consisting of a branched or linear hydrocarbon chain with 1 - 12 carbon atoms;

the compound has a melting point of less than 100° C; and

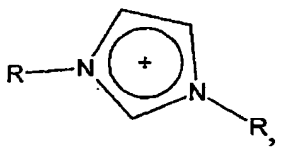
the cation is a nitrogen-containing cation selected from the group consisting of a quaternary ammonium cation, an imidazolium cation, a pyridinium cation, a pyrazolium cation, a phosphonium and a triazolium cation.

3) (Previously Amended) The method of claim 2, wherein the cation is selected from the group consisting of:

a) quaternary ammonium cation with the general formula $(NR_1R_2R_3R)^+$;

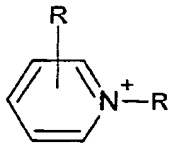
b) phosphonium cation with the general formula $(PR_1R_2R_3R)^+$;

c) imidazolium cation with the general formula



in which the imidazole core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group;

d) pyridinium cation with the general formula



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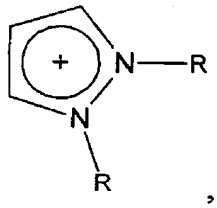
in which the pyridine core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group;

e) pyrazolium cation with the general formula



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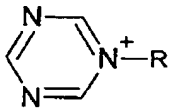
in which the pyrazole core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group; and

f) triazolium cation with the general formula



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in which the triazole core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group; wherein

g) the radicals R^1, R^2, R^3 are selected independently at each occurrence from the group consisting of:

i) hydrogen;

ii) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

iii) heteroaryl groups, heteroaryl-C_1-C_6 alkyl groups with 3 to 8 carbon atoms in the heteroaryl radical and at least one heteroatom selected from N, O and S which is optionally substituted with at least one group selected from C_1-C_6 alkyl groups and/or halogen atoms;

iv) aryl, aryl-C_1-C_6 alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C_1-C_6 alkyl group and/or a halogen atom; and

h) the radical R is selected from the group consisting of:

i) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

ii) heteroaryl-C_1-C_6 alkyl groups with 3 to 8 carbon atoms in the aryl radical and at least one heteroatom selected from N, O and S, which is optionally substituted with at least one C_1-C_6 alkyl group and/or halogen atom; and

iii) aryl-C_1-C_6 alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C_1-C_6 alkyl group and/or halogen atom.

4) (Previously Amended) The method of claim 2, wherein the anion has an empirical formula selected from the group consisting of $C_4H_9SO_4$, $C_8H_{17}SO_4$ or $C_{12}H_{25}SO_4$.

5) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 has a melting point of less than 75° C.

6) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 has a melting point of less than 50° C.

7) (Previously Amended) The method of claim 2, wherein ($R'SO_4$) is an alkyl sulfate ester, wherein the alkyl moiety is selected from the group consisting of butyl, octyl, 2-ethylhexyl, and dodecyl; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

8) (Previously Amended) The method of claim 7, wherein the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium, trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium.

9) (Previously Amended) The method of claim 2, wherein the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium, trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

10) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 is used in a reaction catalyzed by a transition metal; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

11) (Previously Amended) The method of claim 10, wherein the compound of the Formula 1 is used in a hydroformylation reaction, oligomerization reaction, esterification reaction, isomerization reaction or amide bond-forming reaction.

12) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 is used in a reaction catalyzed by an enzyme or biocatalyst; and the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

13) (Previously Amended) The method of claim 12, wherein the compound of the Formula 1 is used in an oligomerization reaction, C-C bond-forming reaction, esterification reaction, isomerization reaction, or amide bond-forming reaction.

14) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous solution (pH = 7) up to 80° C.

15) (Previously Amended) The method of claim 2, wherein the compound of the Formula 1 has a melting point of less than 25° C.

16) (Previously Amended) The method of claim 2, wherein the compound is selected from the group consisting of:

a) 1-ethyl-3-methylimidazolium butyl sulfate;

b) 1-ethyl-3-methylimidazolium octyl sulfate;

c) 1-ethyl-3-methylimidazolium 2-ethylhexyl sulfate;

d) 1-ethyl-3-methylimidazolium dodecyl sulfate;

e) 1-butyl-3-methylimidazolium butyl sulfate;

f) 1-butyl-3-methylimidazolium octyl sulfate;

g) 1-butyl-3-methylimidazolium 2-ethylhexyl sulfate;

h) 1-butyl-3-methylimidazolium dodecyl sulfate;

i) 1-hexyl-3-methylimidazolium butyl sulfate;

j) 1-hexyl-3-methylimidazolium octyl sulfate;

k) 1-hexyl-3-methylimidazolium 2-ethylhexyl sulfate;

l) 1-hexyl-3-methylimidazolium dodecyl sulfate;

m) 1-octyl-3-methylimidazolium butyl sulfate;

n) 1-octyl-3-methylimidazolium octyl sulfate;

o) 1-octyl-3-methylimidazolium 2-ethylhexyl sulfate;

p) 1-octyl-3-methylimidazolium dodecyl sulfate;

q) 1-decyl-3-methylimidazolium butyl sulfate;

r) 1-decyl-3-methylimidazolium octyl sulfate;

s) 1-decyl-3-methylimidazolium 2-ethylhexyl sulfate;

t) 1-decyl-3-methylimidazolium dodecyl sulfate;

u) 1-dodecyl-3-methylimidazolium butyl sulfate;

v) 1-dodecyl-3-methylimidazolium octyl sulfate;

w) 1-dodecyl-3-methylimidazolium 2-ethylhexyl sulfate;

x) 1-dodecyl-3-methylimidazolium dodecyl sulfate;

y) 1-butyl-pyridinium butyl sulfate;

z) 1-butyl-pyridinium octyl sulfate;

aa) 1-butyl-pyridinium 2-ethylhexyl sulfate;

bb) 1-butyl-pyridinium dodecyl sulfate;

cc) trimethyldecylammonium butyl sulfate;

dd) trimethyldecylammonium 2-ethylhexyl sulfate;

ee) trioctylmethylammonium butyl sulfate;

ff) trioctylmethylammonium octyl sulfate;

gg) trioctylmethylammonium 2-ethylhexyl sulfate;

hh) trioctylmethylammonium dodecyl sulfate;

ii) trimethyldecylammonium butyl sulfate;

jj) trimethyldecylammonium octyl sulfate;

kk) trihexyltetradecylphosphonium butyl sulfate;

ll) trihexyltetradecylphosphonium octyl sulfate;

mm) trihexyltetradecylphosphonium 2-ethylhexyl sulfate;

nn) trihexyltetradecylphosphonium dodecyl sulfate; and the method comprises the step of:

employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

17) (Currently Amended) A method of using a compound of the Formula 1 in a process

$$(\text{cation})(R'SO_4)$$

Formula 1

comprising the step of: employing the compound as a solvent, or solvent additive in a chemical process, ~~or~~ ; employing the compound as an extraction solvent for a material separation; or employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit, wherein:

R' is selected from the group consisting of a linear or branched, saturated or unsaturated, aliphatic or alicyclic, functionalized or non-functionalized alkyl radical with 3-36 carbon atoms, wherein R' is optionally functionalized with one or more X groups; X is selected from the group consisting of an –OH, -OR'', -COOH, -COOR'', $-NH_2$, $-SO_4$, -F, -Cl, -Br, -I or –CN; and R'' is selected from the group consisting of a branched or linear hydrocarbon chain with 1 - 12 carbon atoms;

the compound has a melting point of less than 100° C;

the cation is a nitrogen-containing cation selected from the group consisting of a quaternary ammonium cation, an imidazolium cation, a pyridinium cation, a pyrazolium cation, a phosphonium and a triazolium cation;

the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous solution (pH = 7) up to 80° C.

18) (Previously Amended) The method of claim 17, wherein ($R'SO_4$) has an empirical formula selected from the group consisting of $C_4H_9SO_4$, $C_8H_{17}SO_4$ or $C_{12}H_{25}SO_4$, and; the method comprises the step of: employing the compound as a solvent, solvent additive, or extraction solvent; or employing the compound as a heat carrier, or heat carrier additive; or employing the compound as a phase transfer catalyst.

19) (Currently Amended) A method of using a compound of the Formula 1 in a process

(cation)($R'SO_4$)
Formula 1

comprising the step of: employing the compound as a solvent, or solvent additive in a chemical process, ~~or~~ ; employing the compound as an extraction solvent for a material separation; or employing the compound as a heat carrier, or heat carrier additive in a heat exchange unit, wherein:

a) ($R'SO_4$) is an alkyl sulfate ester, wherein the alkyl moiety is selected from the group consisting of butyl, octyl, 2-ethylhexyl, and dodecyl;

b) the cation is a nitrogen containing cation selected from the group consisting of 1-ethyl-3-methylimidazolium, 1-butyl-3-methylimidazolium butyl, 1-hexyl-3-methylimidazolium, 1-octyl-3-methylimidazolium, 1-decyl-3-methylimidazolium, 1-dodecyl-3-methylimidazolium, 1-butyl-pyridinium, trimethyldecylammonium, trioctylmethylammonium, trimethyldecylammonium, and trihexyltetradecylphosphonium;

c) the compound has a melting point of less than 100° C; and

d) the compound of the Formula 1 is substantially hydrolytically stable in neutral aqueous solution (pH = 7) up to 80° C.

20) (Previously Amended) The method of claim 19, wherein the process is a reaction catalyzed by a transition metal, and the reaction is a hydroformylation reaction, oligomerization reaction, esterification reaction, isomerization reaction or amide bond-forming reaction.

21) (Previously Amended) The method of claim 19, wherein the process is a reaction catalyzed by an enzyme or biocatalyst, and the reaction is an oligomerization reaction, C-C bond-forming reaction, esterification reaction, isomerization reaction, or amide bond-forming reaction.

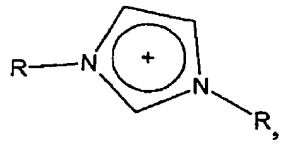
22) (Previously added) The method of claim 18, wherein the cation is selected from the group

consisting of:

a) quaternary ammonium cation with the general formula $(NR_1R_2R_3R)^+$;

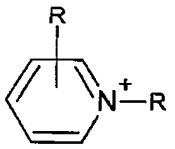
b) phosphonium cation with the general formula $(PR_1R_2R_3R)^+$;

c) imidazolium cation with the general formula



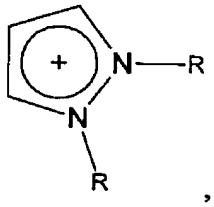
in which the imidazole core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group;

d) pyridinium cation with the general formula



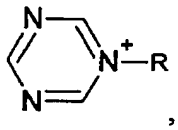
in which the pyridine core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group;

e) pyrazolium cation with the general formula



in which the pyrazole core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group; and

f) triazolium cation with the general formula



in which the triazole core is optionally substituted with at least one group selected from C_1-C_6 alkyl group, C_1-C_6 alkoxy group, C_1-C_6 aminoalkyl group, C_5-C_{12} aryl group or C_5-C_{12}-aryl-C_1-C_6 alkyl group; wherein

g) the radicals R^1, R^2, R^3 are selected independently at each occurrence from the group consisting of:

i) hydrogen;

ii) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

iii) heteroaryl groups, heteroaryl-C_1-C_6 alkyl groups with 3 to 8 carbon atoms in the heteroaryl radical and at least one heteroatom selected from N, O and S which is optionally substituted with at least one group selected from C_1-C_6 alkyl groups and/or halogen atoms;

iv) aryl, aryl-C_1-C_6 alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C_1-C_6 alkyl group and/or a halogen atom; and

h) the radical R is selected from the group consisting of:

i) linear or branched, saturated or unsaturated, aliphatic or alicyclic alkyl groups with 1 to 20 carbon atoms;

ii) heteroaryl-C_1-C_6 alkyl groups with 3 to 8 carbon atoms in the aryl radical and at least one heteroatom selected from N, O and S, which is optionally substituted with at least one C_1-C_6 alkyl group and/or halogen atom; and

iii) aryl-C_1-C_6 alkyl groups with 5 to 12 carbon atoms in the aryl radical, which is optionally substituted with at least one C_1-C_6 alkyl group and/or halogen atom.